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STUDY OF FACILITIES IN GHANA, TANZANIA AND ETHIOPIA FOR TRAINING OF ENGINEERS IN SELECTED DISCIPLINES

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S U M M A R Y

This report gives proposals for strengthening and expansion of the School of Engineering, University of Science and Technology, Kumasi, Ghana; the Faculty of Engineering, University of Dar-es-Salaam, Dar-es-salaam, Tanzania; and the Faculty of Technology, Addis Ababa University, Addis Ababa, Ethiopia.

The report starts by outlining the historical background and the objectives of the respective institutions. For each institution the present state and conditions of the institution with respect to student, academic and technical staff, space, equipment and other materials are presented. The short and long term plan and growth prospects of each institution are discussed. The additional requirements to meet the projected growth in terms of space, equipment and academic staff are also presented. In the three institutions, the expanded facilities will, in addition to upgrading the current programmes, enable them to initiate programmes of study in new areas of engineering specialization.

Finally, pilot project proposals including investment requirements in USD and lists of major equipments are presented for realizing the strengthening and expansions of the three institutions.

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SCHOOL OF ENGINEERING
UNIVERSITY OF SCIENCE AND TECHNOLOGY
KUMASI, GHANA

1.1 INTRODUCTION

Formal engineering training began in Ghana with operation of an Engineering Department in Achimota between the late 1930's and early 1940's. When the then Kumasi College of Technology was established on the 6th October 1952, the School of Engineering was one of the first academic units provided for in the new institution. The School initially prepared its students for membership of various professional Institutions in the United Kingdom between 1952 and 1955, when the formal training of graduate engineers of various specializations commenced in special relationship with the University of London whose External Bachelor of Science (Engineering) examinations were taken by the students of the School of Engineering.

On the attainment of University status in 1960, the School began preparing engineering students for its own degrees and diplomas, the first of which were awarded in 1964.

The status of the School was changed to that of Faculty in the mid-1960's probably to ensure conformity with the status of other academic units which were established on the attainment of University status. This change in status, however, created various problems, not least among which was the inability of the Faculty to maintain, modernise and/or upgrade its infrastructural and equipment stock over the years as a result of steadily diminishing resource allocations in the face of rapidly increasing student population. In an effort to address the peculiar problems experienced by the Faculty of Engineering in the past two decades, the Government decided to fund the Faculty independently of the University as from 1st January, 1987 - a move which necessarily entails a change in the status of the Faculty of Engineering to the School of Engineering.

Being the only tertiary-level institution for the training of engineers at both the professional and sub-professional level in Ghana, the School of Engineering has consistently related its programmes to the requirements of the national economy. Over the past two decades, the Faculty of Engineering had produced both professional and sub-professional engineering man-power in the following specialised areas to service the demands of the economy: Chemical Engineering, Civil Engineering, Electrical and Electronic Engineering, Geodetic Engineering, and Mechanical Engineering.

In addition to these, various Departments of the School or Engineering play active part in the training of Agricultural Engineers, in conjunction with the Faculty of Agriculture, and in the training of Mining Engineers, Geological Engineers and Metallurgical Engineers, in association with the Institute of Mining and Mineral Engineering.

Apart from its normal academic duties of teaching and research, the School of Engineering also maintains and operates a number of Production Units which serve not only as means of demonstrating the viability of its research finding and development activities, but also provide avenues for relevent practical training for its students.

The School of Engineering is the oldest academic unit with the largest student population in the University of Science and Technology, Kumasi. At the time of establishment in 1952, its equipment holding and buildings were adequate and comparable to those of similar institutions elsewhere. Over the years, normal wear and tear, and lack of resources for effective maintenance and replacement of obsolete equipment, have reduced facilities in the School to the level of disrepair.

The present building of the School were put up more than three decades ago for relatively small student populations. However, student intake into all Department in the School has more than quadrupled in the past decade, in response to national demands for trained high-level engineering man-power. The resulting situation is that current laboratory, classroom and office space available in the School is grossly inadequate for the student numbers utilising these facilities.

Polytechnics are equipped to take over. While every effort would be made to contribute to the training of vitally needed middle-level manpower by accomodating requests from other sectors of the economy, it is proposed, in the long-term, to encourage the progressive transfer of all sub-degree programmes to the Polytechnic.

1.2.1.2 Under-Graduate Programme

The degree programmes of study are concerned with the analysis, planning, design, construction/manufacture and management, and operation in various areas of engineering. The professions embrace many inter related specializations in each field of engineering. The degree programmes aim at creating a leading experience for the student so that at the end of the course the student shall be able to make analysis for preliminary design of a defined range of engineering works; define and conduct measurements that will enable him to make fundamental engineering analysis; and to give effective assistance to professional engineers in analysis, design, construction/manufacture and management of engineering systems.

Recently, innovations like introducing engineering design courses aimed at orienting under-graduates to the realities of practising engineers in a typical developing country situation, will be continued to be introduced into the programme from time to time. In particular, it is intended to encourage the introduction of courses relating to the availability, properties and utilization of locally available materials and other appropriate technology concepts. This goal is to be attained through regularly scheduled courses, seminars and final year student research projects.

To broaden the outlook of the under-graduates, it is proposed to initiate student exchange programs with link Departments in Universities in other countries. A pilot programme is currently being discussed with the University of Manitoba in Winnipeg, Canada. Depending on the experiences gained from the operation of the Scheme and subject to the availabiltiy of funding, it is proposed to make similar arrangements with Universities in Africa and elsewhere.

1.2.1.3 Post-Graduate Degree Programmes

The general objective of the post-graduate programme of study is to develop and advance knowledge unique to a special field of study, to provide knowledge and skills in a specialist field and to provide continuing education for practicing engineers. It is expected that engineers with post-graduate training will provide the leadership in analysis, design, construction/manufacture and operation.

Previous attempts at developing post-graduate programmes have resulted in only partial success. While the desirability of post-graduate programmes is not in dispute, the economic condition prevailing is the country during the past decade have made studies abroad more attractive to potential graduate students. This fact, coupled with the relatively easy availability of opportunities for pursuing graduate studies abroad (including government scholarships) made it difficult for the School to attract suitable graduate students in the past. Some limited success, however, achieved in mounting post-graduate programmes at the M.Sc. level in a few disciplines. It is now intended to reactivate existing plans for initiating post-graduate programmes in certain key areas.

The whole question of the development of post-graduate courses is currently under active consideration by the University, with provision being made for broad-based professional (Master of Engineering) type programmes side by side with the academic (Master of Philosophy) research degrees.

1.2.1.4 Continuing Education

The main objectives of continuing education is to facilitate the introduction of the practising engineer to recruit developments and research findings in the relevent field, while also introducing the academic to research priorities in the given area. Continuing education programmes are designed to provide a common platform for academics and practising engineers to review the state-of-the-art of specific facets of the profession.

Continuing education programmes have been carried out in the School to a limited extent to the past. Subject to the availability of funds, it is proposed to organize at least one such programme per Department a year in selected areas of importance to the national economy in association with appropriate local

professional groups and external organizations and agencies. The programmes may take the form of a refresher course, a workshop or a seminar depending on the circumstances. The School believes that this could be our more effective means of disseminating research finding, as well as addressing the pressing problem of the obsolescence in practising engineers.

1.2.1.5 Research and Development

Methods to be used and the inputs required in the research that will be carried out within the School will be the following:

a) Undertaking joint externally funded research in critical areas of the national economy, with Universities and other research orginisations in Ghana and elsewhere

b) Undertaking contract research and consultancy work for identifiable, User-Agencies in both the public and private sectors in Ghana. This may also include running full time post-graduate courses to train manpower for specific sectors of the economy or running School refresher courses for the same purpose.

c) Making direct appeals to identifiable external Doner Agencies for support in specific areas.

Apart from its normal academic activities, the School of Engineering maintains and operates a number of Production Units which serve not only as a means of demonstrating the viability of its research findings and development activities, but also provide avenues for relevent practical training for its students.

1.2.1.6 Consultancy

By undertaking consultancy work the School aims to accomplish the following:

a) obtain a positive way in which the School can make a contribution to national development

b) benefit the School in enhancing the quality of teaching of the staff involved

c) supplement both the School and individual incomes.

In carrying out consultancy works, emphasis is placed on encouraging those requiring specialized skills of staff rather than routine work. It is also intended to exercises some control on the extent of staff involvement in consultancy in order to ensure that it does not adversely affect academic work.

1.3 PRESENT STATE AND CONDITIONS OF THE SCHOOL OF ENGINEERING

To attain the above set of objectives it would be required to have certain minimum level in both staffing and physical facilities thus requiring for additional investment in both manpower and physical facilities. To justify the additional investment a review of the present conditions of the School will first be made in the areas of space, staffing, student population, equipment, and materials.

1.3.1 Students

The admission requirements to the degree programmes are passes in the General Certificate of Education at Advanced Level in Mathematics, Physics and Chemistry. Candidates with an Advanced Level pass in Pure Mathematics, Applied Mathematics and Physics, together with an Ordinary Level pass in Chemistry or Mathematics, Physics and an appropriate third Advanced Level pass, together with an Ordinary Level pass in Chemistry will also be considered.

The admission requirements for sub-degree programmes is the Ordinary Technicians Diploma of the City and Guilds Institute awarded by the Ploytechnics of Ghana.

The student intake of the 1988/89 academic year in the different departments of the School is shown in Table 1.1.

Table 1.1 Student Enrollment by Department and Year, April 1980

Department	Year				Total
	I	II	III	IV	
I M.Sc Programmes					
Chemical Engineering	1				1
Civil Engineering	3	-	-	-	3
Mechanical Engineering	1	-	-	-	1
II B.Sc Programmes					
Chemical Engineering	20	16	15	25	76
Civil Engineering	38	30	39	35	142
Electrical Engineering	29	42	15	21	107
Geodetic Engineering	19	24	18	23	80
Mechanical Engineering	45	35	35	38	153
III Diploma Programme					
Civil Engineering	25	27	-	-	52
Electrical Engineering	5	8	-	-	13
Environmental Health	7	7	-	-	14
Technology					
Geodetic	7	4	-	-	11
Mechanical	3	16	-	-	19
TOTAL	151	209	122	142	651

1.3.2 Staff Condition

The number of academic and technical staff in the School including those at post and approved establishment is shown in Table 1.2 enumerated by Department and academic rank. Table 1.3 shows the technical staff of the School.

As can be seen in the Tables, the School is faced with academic and technical staff shortage. The School has pursued an active policy of staff development through the award of post-graduate scholarships to deserving students over the past two decades. Unfortunately, poor conditions of service for academic staff, coupled with unfavourable economic conditions in Ghana have resulted in a negligible percentage of the recipients of these awards returning to the service of the University. This has forced the University to modify its policy in recent years by restricting such awards to serving members of staff. The University has therefore evolved a policy of encouraging academic staff to undertake all or part of their research towards higher degrees locally. An encouraging start has been made in this connection and it is proposed to make effective use of link arrangements in this regard by encouraging academic staff to submit aspects of on-going co-operative research projects for higher degrees. Such arrangements could make provision for research staff to make short visits to Link Departments for the purpose of taking courses, carrying out parts of research work or consulting with supervisors. It is hoped that this approach will go a long way to enable a build-up staff strength.

Table 1.2 Post and Approved Establishment Academic Staff, April 1980

Departments	Assoc. Professor (Professor)	Senior Lecturer	Lecturer	Technical Instructor	Research Fellow	Total
Chemical Engineering	(1)	- (2)	6 (7)	- (1)	- (1)	6(12)
Civil Engineering	2 (2)	2 (5)	13 (11)	2 (2)	1 (2)	20(22)
Electrical Engineering	- (2)	2 (4)	10 (10)	1 (1)	1 (1)	14(18)
Geodetic Engineering	(2)	- (4)	6 (6)	4 (5)	3 (2)	13(18)
Mechanical Engineering	1 (5)	2 (8)	9 (12)	2 (3)	3 (2)	17(30)
Total	3 (12)	6 (22)	44 (46)	9 (12)	8 (8)	70(100)
Percent of Total	4 (12)	9 (22)	63 (46)	13 (12)	11 (8)	100(100)

Note: Figures in the parentheses are approved establishment academic staff.

Table 1.3 Past and Approved Establishment Technical Staff, April 1989

Department	Chief Technician	Principal Technician	Senior Technician	Technician	Total
Chemical Engineering	- (1)	- (1)	1 (3)	- (4)	1 (9)
Civil Engineering	- (1)	1 (2)	4 (5)	1 (5)	6 (12)
Electrical Engineering	1 (1)	3 (4)	1 (3)	- (2)	5 (10)
Geodetic Engineering	- (1)	1 (1)	1 (2)	- (2)	2 (6)
Mechanical Engineering	- (1)	3 (1)	6 (6)	3 (6)	12 (14)
Total	1 (5)	8 (8)	13 (19)	4 (19)	26 (51)

Note: Figures in the parentheses areapproved establishment technical staff

1.3.3 Space

The present buildings of the School were put up more than three decades ago for relatively small student populations. However, student intake into all Departments in the School has more than quadrupled in the past decade, in response to national demands for trained high-level engineering man-power. The resulting situation is that current laboratory, classroom and office space available in the School is grossly inadequate for the student numbers utilizing these facilities. Furthermore, because of roof leakage, most of the available buildings cannot even be occupied all year round, thus not only leading to under-utilization of existing facilities, but also putting expensive and sensitive equipment at risk as a result of poor storage conditions. The School has submitted to Government a project document to the Public Investments Programme Office of the Ministry of Finance and Economic Planning through the National Council of Higher Eduction relating to the Rehabilitation of Buildings. There are strong indications for the project to materialize in the near future.

The need for the expansion of the space facilities available in the School have been recognized as far back as 1962, when plans were drawn up for a new laboratories to cater for expected expansion in student intake in the 1 70's and 1980's.

These plans were revised and updated in the 1970's and construct egan in 1980, but had to be suspended after completion o. the basement structure for lack of funds.

A Summary of the teaching classrooms, lecture halls, laboratories and offices is shown in Table 1.4.

Table 1.4 Classrooms, Lecture Halls, Laboratories and Offices, April 1989

Description	Seating Capacity	Description	Seating Capacity
1. Lecture Halls	75	5. Chemical Engineering Laboratories	
2. Class Rooms	40	Unit Operation I	20
	54	Unit Operation II	20
	54	Process Development	20
	40	6. Civil Engineering Laboratories	
	32	Geotechnical	25
	62	Highway & Transportation	25
	80	Water Resources	20
3. Drawing Rooms	19	Structural Materials & Engineering	20
	35	Public Health Engineering	20
	16	7. Electrical Engineering Laboratories	
	28	Electrical Power & Machine	25
4. Offices	27	Measurement	20
		Radio & TV	20
		Telecommunications	20
		8. Geodetic Engineering Laboratories	
		Photogrammetry	20
		9. Mechanical Engineering Laboratories	
		Workshop (machine, carpentry, welding autoshop, prodoction unit)	50
		Heat Engine	20
		Mechanics of Machines	20
		Strength of Materials	20
		Metallurgy	15
		Metrology	15
		Solar Energy	20

1.3.4 Equipment and Other Materials

1.3.4.1 Laboratory Equipment and Supplies

While there has been considerable increase in student population in all Departments in the past two decades, there has not been the corresponding investment in the acquisition of modern laboratory and teaching equipment, to replace obsolete equipment and upgrade the equipment stock in all laboratories and the procurement of replacement parts, chemicals, and components for the maintenance of existing equipment.

The result has therefore been that the country's high level engineering-man-power is being trained with facilities which were installed over two decades ago. For example the country has officially changed to the metric system over fifteen years ago, but the country's future engineers are being trained with equipment calibrated in imperials units. There is therefore an urgent need to modernise and increase basic teaching and research equipment holding in all laboratories to levels which will considerably improve the training of all classes of engineering students, and to maintain adequate supplies of essential spares, components and chemicals required for laboratory work.

1.3.4.2 Textbooks, Teaching Materials and Periodicals

The School currently maintains the largest library in the University, apart from the main University Library. However most of the books are out of date. The library also lacks microfish and reprographic facilities which are necessary if the facilities offered by the library are to be fully utilized.

1.3.4.3 Personal Computers

It is absolutely essential that the training of the modern engineer be related to the use of the computer. Although a modest start of a School Computer Facility has been made, it is imperative to add to the Units in this facility to bring the capacity of the facility to such level as to ensure that the average engineering student will obtain adequate exposure to develop computer utilization skills during the course of his study.

1.3.4.6 Vehicles

Frequent and periodic field visits are necessary if the various Departments in the School are to relate their teaching and research to local field conditions. Apart from project vehicles obtained for specific projects, the School does not have any other vehicles for field work.

1.4 DEVELOPMENT PLAN AND GROWTH PROSPECT

In the forgoing sections attempt was made to show the capacity and capabilities of the School in terms of student population, physical facilities and staff conditions. It was also shown that the School is currently operating with a student population far in excess of its design capacity and that it is adversely affecting the quality of instruction and research activities. In spite of the constraints and difficulties the School is adequately carrying out its responsibilities in the training of qualified sub-professional and professional engineers that the country needs.

In order that the School carry out the objectives stated in section 1.2, the planning of the required inputs that would enable the School to meet its responsibilities and the execution of the planned activities have to be fixed in time. In view of the growing technical manpower requirements of the country in several fields or specialization at different levels of qualification, proposals are being made to upgrade the School of Engineering. The main thrust of these proposals lies in the effective utilization of existing infrastructure and experience to improve existing programmes of study.

The upgrading and expansion of the School may be accomplished by alleviation of current problems in space, equipment and staff and the long term expansion and reorganization of the School in view of the objectives stated in section 1.2. The plan need not necessarily be accomplished sequentially in time, however, for ease of presentation the two aspects of the expansion and upgrading will be presented separately.

1.4.1 Long-Term Expansion

The long-term development of the School will be to expand and strengthen existing programmes of study and to expand graduate instruction and research. The development plan envisages the reorganization of the School, an increase of student

relate also the expansion in the programmes of study both at the under-graduate and graduate levels. The additional investments that will be necessary to accomplish the planned activities will also be presented.

At this stage of this proposal some of the investment costs presented will of necessity be rough estimates and will be refined in the later stages.

1.4.1.1 Reorganisation of the School

The main reorganisation desired will include the physical locations of the various functional units of the School so as to help in the rational and effective use of facilities and capabilities. It is therefore proposed to organise the School as follows:

a) Relocate the laboratories of the Civil Engineering to a new building (where construction was started in 1981 but now suspended due to lack of funds). This will enable the Electrical and Electronic Engineering and Mechanical Engineering Departments to expand into space vacated by the Civil Engineering Department.

b) Relocate the Department of Chemical Engineering to a new building near the premises of the School of Engineering. The Chemical Engineering Department is currently temporarily housed in the building of the Chemistry Department.

c) Relocate the Department of Geomatic Engineering to a new building. The Department is currently temporarily housed in various Engineering Departments.

1.4.1.2 Expansion of Student Intake

The increase in the student intake is governed by the current capacities and the realistic possibilities for the physical expansion that can be undertaken by the School. It is therefore proposed to increase the student intake of the School from the current 125 to 235 per annum in the under-graduate programmes. The breakdown of the under-graduate student intakes into the various existing departments is presented in Table 1.5. The requirements for this expansion of student intake are presented in Section 1.4.2.

Table 1.5 Proposed Annual Under-Graduate Student Intakes

Department	Current Student Intake	Proposed Student Intake
Chemical Engineering	15	25
Civil Engineering	40	100
Electrical Engineering	25	50
Geodetic Engineering	20	30
Mechanical Engineering	25	30
Total	125	235

With an annual intake of 235 students into the various departments offering under-graduate programmes of study and assuming annual attrition of 5%, the School will have a student population of about 900. This represents an 80% increase in the under-graduate student population.

1.4.2. Additional Requirements to Meet the Projected Growth

The projected expansion in the student intake in the under-graduate programmes, the launching of post-graduate programmes and the expected growth of research activities of the Faculty, would require additional investments for additional space, laboratory facilities and academic and technical staff. The additional investment should also aim at alleviating current problems. These requirements are based on the assessments of the Departments of the School, taking into consideration existing conditions, the proposed expansion and current constraints.

1.4.2.1 Space Requirements

Additional space requirements of the School for lecture halls, classrooms and laboratories are presented in Table 1.6. The additional lecture halls, classrooms and laboratories will be required for the proposed relocations and the added number of students.

Table 1.6 Additional Space Requirements

Department 'Laboratories under Department	Lecture Hall or Classroom Number	 Seating Capacity	Laboratories (m^2)	Offices Number (Area)
1. Chemical Engineering	5	25	-	16
. Unit Operation I	-	-	100	($80m^2$)
. Unit Operation II	-	-	100	
. Food Processing	-	-	100	
. Controls	-	-	100	
. Petroleum Testing Unit	-	-	100	
2. Civil Engineering	5	100	-	8
. Highway Engineering	-	-	100	($40m^2$)
. Hydraulics	-	-	100	
. Concrete	-	-	100	
. Design Room	-	-	100	
3. Electrical Engineering	2	40		5
. High Voltage	-	-	100	($25m^2$)
. Computer	-	-	100	
. Microprocessor	-	-	100	
. Digital	-	-	100	
4. Geodetic Engineering	5	30	-	15
. Photogrammetry	-	-	100	($75m^2$)
. Cartography	-	-	100	
. Photo Interpretation	-	-	100	
. Hydrographic Surveying	-	-	100	
. Remote Sensing	-	-	100	
5. Mechanical Engineering	2	30	-	5
. CAD/CAM			100	($25m^2$)
SUB TOTAL	19	915	$1900m^2$	49($245m^2$)

6. Space for Common Services				
. Library	1	500	-	
. Multipurpose	1	500		
. Production Units	-	-	-	2(50m^2)
. Industrial Relation				
. Directrate	-	-	-	4(30m^2)
SUB TOTAL	2	1000	-	2(30m^2)

1.4.2.2 Staff Requirements

To implement the proposed programmes the minimum requirements in academic and other technical personnel is given in Table 1.7. This is in addition to the existing establishment.

Table 1.7 Staff Requirement

Department	Professor	Senior Lecturer	Lecturer	Technical Instructor	Technical Assistant	Technician
Chemical Engineering	2	2	3	2	2	2
Civil Engineering	4	4	11	3	5	8
Electrical Engineering	2	4	9	2	3	7
Geodetic Engineering	-	2	4	5	3	6
Mechanical Engineering	1	1	2	1	1	-
TOTAL	9	13	29	13	14	23

The staff requirements in the senior academic ranks could initially be filled with Ghanians currently outside the country for want of job satisfaction, supplemented where necessary, by the employment of expatriates. It may be noted in this convection, that the Ghana Government currently has a programme of attracting qualified Ghanians in various fields back home.

The recruitment of qualified technicians to man the expanded laboratories should be an important component of the overall staff development plan. The development of qualified technical staff will also require the maintenance of a stable group of technical personnel. The School will have, therefore, to provide a scheme of training to upgrade the quality of its technicians and also provide an organizational structure through which qualified and deserving personnel can be promoted.

1.2.3 Investment Required for Upgrading of the School

In this Section the estimated costs for the additional constructions, equipment and teaching facilities are presented in Table 1.8. For estimating the construction cost an average rate of US $600 per square meter is used.

Table 1.8 Estimated Cost of Additional Requirements

	Item	Area in m^2	Cost in U.S $
1	Lecture Halls & Classrooms	$1830m^2$	1,098,000
2	Laboratories	$1900m^2$	1,140,000
3	Offices	$275m^2$	165,000
4	Library	~~$750m^2$~~	450,000
5	Multi Purpose Hall	$750m^2$	450,000
6	Common Supporting Services	$300m^2$	180,000
7	Equipment*		4,509,000
8	Text books & Teaching Materials, Photo-copying machine		100,000
9	Computers		200,000
10	Consumable Supplies		50,000
11	Vehicles		150,000
12	Contingency Costs (5%)		326,000
	TOTAL in US $		6,308,000

*Major items in the equipment lists are shown in Table 1.9.

Table I.9 Major Items in the Equipment List

	Department	Equipment
1	Chemical Engineering ($ 450,000)	Rotary evaporator, Rotary dryer, Heat Exchanger, Air to water heat transfer, Stirred reactor, Spectrophonometer, Gas Chromatography, Homogenizer steam generator, Plate distillation column Pit-Module
2	Civil Engineering ($ 550,000)	Analytical balances, Laboratory ovens, Capacity Trailer mounted cone penetrometer, Hydraulic drilling equipment, Universal testing machine, Vortex apparatus
3	Electrical Engineering ($ 500,000)	Three-phase induction motors, Impulse generator, Three-phase alternators, Multimeters, Oscilloscopes, Voltmeters, Network analysers, Transformers, Computers
4	Geodetic Engineering ($ 400,000)	Theodolites, Levels, Satellite tracing equipment stereoscope precision platters, Copy camera, Offset printer
5	Mechanical Engineering ($ 600,000)	Rotary bending fatigue testing machine, Universal vibrator apparatus, Universal governer apparatus, Gas turbine, Diesel engine petrol engine, Steam boiler, Hot furnace, Radial drilling machine, Lathe machines, Gear hobbing machine, Lift crane

FACULTY OF ENGINEERING
UNIVERSITY OF DAR ES SALAAM
DAR ES SALAAM, TANZANIA

2.1 INTRODUCTION

The three University Colleges which had made up the University of East Africa were reconstituted in 1970 as separate Universities in Dar es Salaam, Makarere and Nairobi. At that time, only the University College in Nairobi had a Faculty of supply of engineers for Tanzania. The Faculty of Engineering was established in 1973 with assistance from the Government of the Federal Republic of Germany and commenced with Departments of Civil, Electrical and Mechanical Engineering. At a later stage a new Department of Chemical and Process Engineering was added. The Faculty plays also an active part in the training of Agricultural Engineers during their first two years.

The Faculty of Engineering has emerged now as probably the single most important technical institution in the country with its high concentration of qualified and skilled manpower and sophisticated equipment not available elsewhere in the country. In respect of educational and training objective, the Faculty has produced a number of professional engineers who are servicing various key sectors of the national economy. It has also graduated few engineers with M.Sc in Civil, Electrcial Mechanical, and Water Resources Engineering, the latter being a full-time international programme within the framework of the African Network of Scientific and Technological Institution (ANSTI), for which the Faculty is the Coordinating Institution for Water Resources Engineering.

The development of the Faculty was envisaged to be "completed" within the first decade of its establishment, with consolidation of the under-graduate curriculum, establishment of post-graduate courses, and localisation of the teaching staff. A retrospective analysis of the original functional and development objectives, against the results achieved to date, can lead to an overall assessment of "success", even in the absence of a comprehensive set of pre-established indices of success. Certainly the objectives in terms of student intake and graduation have been well met, and it remains only to judge the quality of the graduates and the impact they are making in the transformation to industrial and technological self-sufficiency. Though this

is difficult to assess, the original survey conducted in the mid 1970's did give some indication that the Faculty's graduates are acquitting themselves well in their professional pursuits and taking up prominent positions in industry and government. Responses from the graduates also indicate a general satisfaction that the curriculum of the Faculty is relevant to their needs, though a more professional problem-solving orientation seems to be suggested. The Faculty is currently conducting a comprehensive survey of both its graduates and their employers to get more information about the curriculum and approach to delivery of same.

The Faculty has recently held a Planning Workshop (26 February - 15 March, 1980) with the objectives of assessing where the Faculty stands (in what has been achieved and what is yet to be done, and to review its objectives); namely to identify some problems and short-comings in the Faculty's operations so as to work a consistent strategy aiming at a possible concentration of efforts and to prepare an overall plan of operation, showing targets to be reached in a given period; measures to improve the performance; human and financial inputs required, and the introduction of a reporting and monitoring system to compare achievements with the targets set.

A proceeding of the Workshop has now being completed, and the Workshop Proceedings will serve: to serve as a guide for the future course of action; to present review findings, strategies and subsequent requirements to obtain the necessary support; and to present the same to the Faculty institutional donors as a basis for a fruitful extended cooperation.

This document will attempt to present the Faculty's objectives, the current capabilities of the Faculty and the additional investments that will be required to meet the set of objectives.

2.2 OBJECTIVES OF THE FACULTY OF ENGINEERING

The major objectives of the Faculty of Engineering is to provide education and advanced training of engineers in various fields of specialization, to perform research in the interest of a suitable exploitation of national resources and development in Tanzania and to provide expert professional services in the form of consultancy to industry, parastals, government and private organizations.

2.2.1 Objectives of the Educational Training Programmes

2.2.1.1 Under-graduate Training

The objective of the under-graduate programmes of the Faculty with respect to education and training is to maintain an output of at least 110 B.Sc graduates per year in the Chemical & Process, Civil, Electrical, and Mechanical Engineering. The Faculty envisages continuous changes of the curricula and the objectives are:

- to conduct periodic reviews of the curricula in conjunction with feedback information from the views of its graduates and their employers to ensure that the Faculty is adressing to the needs of industry and national development.

- to develop professional problem-solving oriented approaches, based on sound theoretical background and principles, and an appreciation for the socio-economical impact of alternative solutions

- to prepare its graduates to adapt to rapidly changing technologies and industrial applications

- to introduce the computer as a basic tool of modern engineering in all Departments.

2.2.1.2 Post-graduate Training

The objectives of the Faculty with respect to the post graduate studies is to operate the programmes by coursework in all Departments in response to the demands of industry for advanced education and training.

2.2.1.3 Continuing Education

The objectives of the Faculty with respect to continuing education is to maintain industrial short courses in all departments as Professional Development Programme.

2.2.2 Objectives of Research

The major objectives of research in the Faculty are:

- to exploit the utility of local materials for design and building of machines and other equipment, and for construction

- to develop locally available sources of alternative energy

- to develop solutions for maintenance and rehabilitation of infrastructure, equipment and machinery

- to develop solutions for local problems in industry and government using the scientific method

- to develop a programme of industry and government sponsored research

- to develop processes for the use of local substitutes to imported raw materials.

2.2.3 Consultancy and Services

The major objective of the Faculty with respect to consultancy and services is to utilize the specialized technical man-power and facilities of the Faculty to meet fully the demands for industrial and engineering consultancy and services.

To achieve this objective the Faculty aims:

- to reach and maintain a volume and value of consultancy and services equivalent to 25% of the total nominal working time of all academic staff

- to increase the volume of research-oriented consultancy

- to distinguish the Faculty of Engineering as a centre of excellence with high-level manpower resources that the Government, parastatals, and private sectors could consult.

2.3 PRESENT STATE AND CONDITIONS OF THE FACULTY OF ENGINEERING

To achieve the objectives set in Section 2.2, it would be required to acquire a minimum state of staffing and physical facilities. Although the objectives stated above would require additional investment both in skilled man-power and physical facilities, a significant portion must necessarily be apportioned as the existing one. This calls for a review of the existing conditions of the Faculty in student population, staffing and space. In what follows, a presentation will be made on current capacities and activities of the Faculty and the constraints prevailing therefrom.

2.3.1 Students

The essential points on the minimum entrance requirements for a four-year education and training programme in the Faculty of Engineering are:

a) A Certificate of Secondary Education Examination (CSEE) or East African Certificate of Education (Ordinary Level) of equivalent with passes in five subjects, obtained prior to the sitting of the Advanced Certificate of Secondary Education or East African Certificate of Education, or equivalent.

b) Principal Level passes in Pure Mathematics, Applied Mathematics or Physics.

OR

Principal Level Passes in Mathematics and Physics or Pure Mathematics and Physics

AND

At least subsidiary Level pass in Chemistry in the Advanced Certificate (CSEE)

The current numbers of students in the 1989/90 academic year in the departments of the Faculty are shown in Table 2.1

Table 2.1 Under-graduate Students enrolled by Department and Year, April 1989

Department	Year				Total
	I	II	III	IV	
Chemical and Process Engineering	-	44	27	19	60
Civil Engineering	-	66	57	53	176
Electrical Engineering	-	21	18	16	65
Mechanical Engineering	-	41	47	31	119
Pre-Engineering	160	-	-	-	160
TOTAL	160	152	149	119	580

Table 2.2 Academic Staff of the Faculty of Enginee

Department	Professor	Associate Professor	Senior Lecturer	L
Chemical & Process E...	1	2	2	
Civil Eng.	2	2	7	
Electrical Engineering.	-	2	2	
Mechanical Engineering	2	2	5	
TOTAL	5	8	16	

Table 2.3 Technical Staff of the Faculty of Engine

Position	Chemical & Process Eng.
Chief Workshop Instructor	-
Workshop Instructor	-
Principal Workshop Instructor	-
Assistant Workshop Instructor	-
Principal Technician	1
Senior Technician	1
Technician	2
Technician Trainees	-
Total	4
Establishment	15
Artisan	8

ng, April 1989

turer	Tutorial Assistant	Total	Establishment	On study Leave
3	13	21	30	5
8	11	40	44	8
3	13	19	21	5
3	13	28	30	12
36	52	108	125	30

ring, April 1989

Civil Engineering	Electrical Engineering	Mechanical Engineering	Technical Workshop
-	-	-	5
-	-	-	2
-	-	-	3
-	-	-	1
1	1	2	4
2	-	2	2
8	3	9	5
2	1	-	-
13	5	13	22
28	8	22	25
20	6	24	37

2.3.2 Staff

The Academic and Technical staff of the Faculty in number, rank and by Department are listed in Tables 2.2 and 2.3, respectively.

2.3.3 Space

The construction of the Faculty of Engineering started towards the end of 1972 after a careful study on the projected space requirement has been established. The financial assistance for construction, equipment and personnel was obtained from the Federal Republic of Germany. For the current intake of 160 students per year as well as for the existing academic and non-academic staff, the space provided in the Faculty is adequate to carry out smoothly its expected duties. A summary of the teaching and laboratory space and offices is shown in Table 2.4.

Since the establishment of the Faculty no major maintenance has been carried out. Consequently, the current condition of the buildings is such that it requires a major rehabilitation work to prevent impending serious deterioration. The Faculty is planning to preserve all buildings which have been seriously deteriotated by planned programme of preventive and periodic maintenance. If the maintenance plan of the Faculty does not materialize in the very near future, the rehabilitation costs could be exhorbitant.

Table 2.4 Classrooms, Lecture halls, Laboratories and Offices of the Engineering, April 1989

	Description	Seating Capacity
1.	Lecture Halls	50
		90
		60
2.	Class Rooms	
	2 Rooms	50
	5 Rooms	40
	4 Rooms	20
3.	Drawing Rooms	60
		40
		40
		30
		20
4.	**Chemical & Process Engineering Laboratories**	
	Chemical Laboratory	12
	Chemical & Process	20
5.	**Civil Engineering Laboratories**	
	Building Materials	60
	Highway & Transportation	15
	Hydraulics	60
	Water Quality	15
	Soil Mechanics	30
	Surveying	60
6.	**Electrical Engineering Laboratories**	
	Electronics & Telecommunication	20
	Measurement & Control	20
	Electrical Power & High Voltage	10
	Electrical Machine & Drives	20
	Computing	22
	Power Electronics	20
	Microprocessing	20
	Workshop	20
7.	**Mechanical Engineering Laboratories**	
	Material Technology	40
	Production Engineering	40
	Mechanics of Machines	40
	Thermo & Fluids	40
	Automotive	20
	Refrigerator & Air Conditioning	20
	Machines	40
	Workshop	20
8.	**Pre-Engineering Workshop**	
	Wood Workshop	12
	Electrical Workshop	12
	Forging, Casting & Welding Workshop	12
	Bench Workshop	12
	Machine Tool Workshop	12
	Building	12
9.	Library	4 Rooms
10.	Offices	140 Rooms

2.3.4 Equipment and Other Materials

2.3.4.1 Laboratory Equipment

After the completion of the construction of the buildings, the Faculty has been provided with a complete and modern set of equipment and laboratory supplies required for a high quality under-graduate training programmes. The Faculty has been receiving from different doner agencies, modern equipment and supplies to keep abreast with the technological changes that have recently taken place. However, due to lack of proper maintenance some of the equipment are not presently operational, thus requiring them to be reconditioned or replaced.

2.3.4.2 Textbooks

A major problem that has dogged the Faculty is the acute shortage of texbooks. The academic staff have responded by compiling some lecture manuscripts and writing textbooks. Some books have been prepared by the staff and have been printed by the Dar-es-Salaam University Press. The economic condition dictating this situation is not likely to improve sufficiently in the near future to give textbooks a priority for scarce exchange.

2.4 DEVELOPMENT PLAN AND GROWTH PROSPECTS

In view of the growing technical manpower requirements of the country in several fields of specialization at under and post-grduate levels of qualification, proposals are being made in this Section to upgrade and expand the Faculty of Engineering. The main thrust of these proposals lies in the effective utilization of existing infrastructure and experience to expand into training in new areas of specialization and the upgrading and expansion of existing programmes of study.

The educational expansion programmes will have the following objectives:

a) To increase the volume of output of graduate engineers in the existing departments according to the national requirements

b) To take steps towards implementation of the Mining Engineering Department

c) To initiate a new Department of Architecture and Planning

d) To expand the industrial short courses in all departments to cater for the growing needs of the country

e) To expand post-graduate programmes in all departments

2.4.1 Expansion of Student Intake

Based on the national requirement, the Faculty is proposing to increase the student intake from the current 160 to 230 per year in the existing under-graduate programmes. The breakdown of student intakes into the various existing departments is shown in Table 2.5.

Table 2.5 Current and Proposed Annual Under-graduate Student Intake

Department	Current Intake	Proposed Intake
Chemical & Process Engineering	40	40
Civil Engineering	60	110
Electrical Engineering	20	40
Mechanical Engineering	40	40
TOTAL	160	230

2.4.2 Space Requirements

Additional classrooms, lecture halls and laboratories will be required for the added student intake and also for upgrading of the programmes. Table 2.6 shows the additional space requirements of the Faculty for lecture halls, classrooms, laboratories and offices.

Department . Laboratory	Lecture Hall & Classroom Number	Capacity	Laboratories m^2	Offices m^2
Chemical & Process Engineering	1	90		
	3			
. Analytical Instrumentation			50	200
. Analytical Lab.			50	
. Research (Post-Graduate)			300	
. Teaching Lab.			200	
. Store			150	
. Library			100	
Civil Engineering	2	50		
. Highway & Transport			100	150
. Water Quality			50	
. Remote Sensing			100	
Electrical Engineering	1			
. Light current			150	
. Heavy current			100	200
. Telecommunications			70	
. Controls			40	
Total	7	250	1220	550

2.4.3.2 Additional Staff Requirements

The staff requirement of the Faculty, in addition to the establishment it already has, to carry out the proposed programmes is shown in Table 2.7.

Table 2.7 Additional Staff Requirements

Department	Academic Staff	Technical Staff
Chemical & Process Engineering		15
Civil Engineering	-	7
Electrical Engineering	0	8
Mechanical Engineering	-	-
Total	0	30

2.4.4 Investment Requirements

The estimated costs for the additional construction, equipment and textbooks for the proposed upgrading and expansion of the Faculty of Engineering are presented in Table 2.8. In estimating the construction costs, an average of US $850 per square is used.

Table 2.8 Investment Requirements

	Description		Cost in US $
1.	Building Construction		
	Classrooms	$350m^2$	
	Laboratory	1320	
	Offices	550	
	Stores	150	
	Library	100	
	Total	$2270m^2$	1,929,500
2.	Chemical & Process Engineering Department		
	. NMR, UV Spectrometer, Mass Spectrometer High Precision Chromatograph, Centrifuge		400,000
3.	Equipment for Civil Engineering Department		
	. Marshall Test Equipment, Triaxial Testing Machine Digital Planimeter, Compression Apparatus, Vane Borer, Nam Sounding Equipment, Stereoscopes, Digital Planimeter		300,000
4.	Equipment for Electrical Engineering Department		
	. Network Analyser, Spectrum Analyser, Oscilloscopes, Signal Generators, Frequency Counters, Micro Computers, Electric Motors and Generators		400,000
5.	Equipment for Mechanical Engineering Department		
	. CAD/CAM System, Spectrometer Scanning Microscope, Numerically Controlled Lathe Machines		600,000
6.	Textbooks		300,000
7.	Contigency (5%)		196,000
	Total		US $ 4,125,500

FACULTY OF TECHNOLOGY
ADDIS ABABA UNIVERSITY
ADDIS ABABA, ETHIOPIA

1.1 INTRODUCTION

The Faculty of Technology, in the last three and half decades of its existence, has gone through significant transformation and growth in terms of its curricula, physical facilities, composition and quality of its teaching staff and research capabilities. The undergraduate instructions within its various departments have undergone a series of changes and development, both in terms of structure and content, so as to be able to meet the ever-growing trained man-power needs of the country.

The central concern of the Faculty, in the development of its teaching activities, has always been the training of engineers who will adequately be prepared to take up engineering assignments in the various sectors of the national economy with the minimum amount of apprenticeship time for practical work. The various curricula of the Faculty are thus designed in such a way as to provide instructions in the fundamental principles and broad aspects of the different disciplines of engineering supported by courses in laboratory exercises that emphasize the practical aspects of the profession. The broad nature of the instructions at the undergraduate level of the Faculty reflects the concrete realities that prevail in the technical background of the incoming students and the nature of engineering assignments the students undertake after graduation. It should, however, be added that designing the undergraduate curricula to be broad has in no way compromised the quality of education in specific specialized fields and the Faculty has maintained an international standard in all the fields of specialization it is currently offering.

In recognition of its high standard the African Network of Scientific and Technological Institutions [ANSTI] has selected the Faculty to be the centre of excellence in the fields of Civil Engineering and Electrical Engineering. The Faculty's selection as the centre of excellence in these areas makes it responsible for the post graduate training and research for Africa in fields of Structural Engineering, Geotechnical Engineering and Communications Engineering.

Engineering training is currently being given in fields of Architecture and Town Planning, Civil Engineering, Chemical Engineering, Electrical Engineering and Mechanical Engineering, all leading to the degree of the Bachelor of Science. There is also a three-year diploma level training in Building Technology. As these fields of study indicate, the undergraduate programs of the Faculty has focused on the traditonal disciplines reflecting the developmental needs of the country.

In the fields of Architecture and Civil Engineering, the Faculty's graduates are successfully carrying out assignments in design and construction of building works, construction of roads and water works. It is gratifying to note that the feedback the Faculty is obtaining from various employing organizations have been appreciative of the quality of the work that is being undertaken by its graduates and a further testimony to the strength of the Faculty's teaching programme in these fields and the soundness of the basic philosophy of training adopted by the Faculty.

Because of the nature and level of development of the Mechanical and Electrical industries in Ethiopia, the Faculty's graduates in these two fields of specialization have mainly been concerned with problem of plant operations, selection and maintenance of equipment, rationalization of production and other related matters. The broad nature of the training programmes in these areas have afforded the graduates the flexibility and versatility necessary to be engaged in diverse planning and operational undertaking in the various sectors of industry.

Despite some inevitable constraints, the various training programmes of the Faculty have successfully contributed, in a responsive manner, their share in the development of technical personnel that the country needed and needs. However, we have now reached a point where the challenges in the training of engineers for the fulfilment of the national economic development plan that is laying the foundations for the socialist construction has become more demanding.

The ten-year perspective plan envisages rapid industrial expansion and development. The successful execution of the planned industrial expansion would certainly require large number of skilled technical personnel (or man-power) in diverse specialized fields and at various levels of qualification. While it will not entirely be possible to train all the necessary man-power in local institution at this time, it becomes imperative to start or initiate training programmes locally for engineers and other technical personnel in some selected and vital areas of specialization. It is believed that the task of providing such programmes of study for the realization of these objectives will, in the immediate future, mainly fall on the Faculty of Technology as the sole institution of higher technical education that has the experience and necessary basic infrastructure on which future developments can be based.

The Faculty of Technology is now prepared to take up this challenge and work towards the rapid realization of the training objectives that will be set by the Party and the Government. To meet this enormous challenge, the Faculty will have to redefine its goals and objectives in both teaching and research.

This document will attempt to present this definition of the Faculty's goals, the current capabilities of the Faculty and the additional investments that will be required to meet the set of objectives.

3.2. OBJECTIVES OF THE FACULTY OF TECHNOLOGY

As mentioned above, the general objective of the Faculty of Technology is to train skilled man-power in various fields of specializations and various levels of qualifications. Within this general objectives, the programmes of study and other activities of the Faculty have to be oriented in such a way as to be responsive to the man-power needs of the country. At this point in the country's development the requirements of skilled technical man-power have grown both quantitatively and qualitatively. In addition, the number of areas of specialization required have also expanded. It has, therefore, become necessary to widen the scope of the objectives of the Faculty of Technology and organize it in such a manner as to make it capable to shoulder the responsi-

bilities encumbered to it. In light of the above, the following are proposed as the set of objectives of the Faculty. All or most of what follows have always been the objectives of the Faculty of Technology but their clear articulation and achievements have been hampered due to various constraints in the past. What is now presented is in line with the educational objectives of the ten-year perspective plan in this area of specialization.

3.2.1 Objectives of the Training Programmes

3.2.1.1 Undergraduate Training

The undergraduate programmes of study will strive to provide broad instructions in both theory and practice in particular areas of engineering. Narrow specialization at the undergraduate level at this time will neither be desirable nor possible. Within this general framework the Faculty will attempt to accomplish the following:

a) Strengthen and upgrade the quality of instructions in both the theoretical and practical spheres. The upgrading and stream lining of the curricula will be a continuous effort that will help in training engineers who are capable of taking assignments in design, construction and operational work that they will encounter in their places of employment. This will also involve the teaching of new techniques and technologies that are constantly being developed. The strengthening of the practical aspect of the training will, hopefully, better prepare the graduating engineers to solve engineering problems that may arise in practice in a more competent manner.

b) Expand the areas of instructions into new fields of specialization by opening new Departments. The opening of new departments of instruction will be based on the expressed man-power needs of the country and would, as much as possible, be initiated as a minor programme of study within one of the existing departments and eventually grow into a full-fledged department.

This approach had been used by the Faculty in the establishment of the Department of Chemical Engineering. The current Chemical Engineering Programme of study has been an outgrowth of a minor

study programme within the Department of Mechanical Engineering. Organizing and conducting a minor Programme of study, had enabled the Faculty to gather experience in conducting such a programme and make the necessary arrangements to provide staff and laboratory facilities for launching a major programme of study in Chemical Engineering.

The experience with the start of the Chemical Engineering programme of study has convinced the Faculty that other areas of specialization could also be initiated within the Faculty with a minimum investment since there are significant number of courses and facilities within the existing programmes that would also be appropriate for new programmes.

In line with this approach the Faculty is currently studying the possibilities of initiating minor programmes of study in the areas of Mining Engineering, Metallurgy and Computer Engineering. Of the above three fields of study, a minor programme of study in Mining Engineering has already been drawn up by the Department of Civil Engineering and is being distributed for further review and comment by relevant organizations and professionals, after which a Workshop will be held [illegible] before being submitted for approval to the University Senate.

The development of these new departments of instruction, while providing the skilled man-power needed in these areas of specialization in the immediate future, will provide a strong basis for the development of other departments and institutes for the training of specialist in these particular fields of study.

c) Training of middle-level technical personnel at the Diploma level. The effectiveness of engineers in carrying out their duties is mostly limited by the number of middle-level technical personnel that would assist them. In the absence of other institutions that train middle level technical personnel in the large numbers required, the Faculty can, at least in the short-run, continue to train these personnel in a strengthened manner.

The importance of these middle-level technical personnel in the construction industry is an often emphasized matter. The Department of Building Technology has, over the past several years, been engaged in the training of such personnel for the construction industry. To make the contributions of the graduates of this Department more effective and more relevant, its programme of study will be expanded and strengthened, especially in the practical aspects of construction technology. In this respect a strengthened Department of Materials Research and Testing will be able to contribute significantly in the improvement of the training given by the Department of Building Technology.

The Continuing Education Division has also contributed significantly in the training of middle-level technical personnel. It is expected that the activities of this division will be strengthened further in such a manner that it may be considered as an important aspect of the overall educational objectives of the Faculty.

c) The organization of regular short training programmes in various fields of specialization for practicing engineers and other technical personnel in various government institutions. Such programmes will provide opportunities for practicing engineers and others to upgrade their knowledge and also acquaint them to new advances in theory, practice and technology. In view of the constantly changing or advancing techniques, the necessity of introducing to practicing engineers the results of these new advances in an organized, systematic and goal specific manner cannot be overemphasized. In addition, the Faculty would be able to organize programmes of study, in an ad-hoc manner, to train engineers in specified areas of specialization to solve the man-power problems of individual or groups of state organizations.

the provision of services of its staff members. These consultancy services will be services rendered to government agencies and departments in the form of technical advice and carrying out feasibility studies. It will also be possible, through the consultancy services, that members of the Faculty will be continuously and intimately involved in the solution of the engineering problems of the country and this will definitely contribute towards making the teaching activities of the Faculty more relevant to the needs of the county.

The organization and operational activies of the consultancy services within the Faculty are currently at a rudimentary stage. These services are limited to providing testing and measurement services when requested by government agencies and other organizations. Apart from the institutional level cooperation with other organizations, staff members of the Faculty have, from time to time, rendered professional services to outside organizations. It is believed that the hither to sporadic consultancy services of the Faculty could be made an intergral function of the Faculty and its effectiveness ensured through the setting up of appropriate organizational frame work within the Faculty. Towards this end, it is thus proposed to organize a Research and Consultancy Department within the Faculty of Technology. The function of this Department will in general be to:

a) Promote and coordinate the research activities of the Faculty.
b) Facilitate the conduct of research work by staff members and students of the Faculty.
c) Actively Solicit consultancy work and coordinate the activities of the other Departments in this area.
d) Oversee the work conducted by the Materials Research and Testing Department.
e) Seek opportunities and (forums) through which the work of Faculty and its potentials for undertaking consultancy services are dissiminated and better known.

While the details of the form this department will take, will be finalized in the future, it is obvious that it will be subordinate to the research and consultancy policy of the University and will function under the overall guidance and supervison of the Research and Publications Committee of the Faculty of Technology.

3.3 PRESENT STATE AND CONDITIONS OF THE FACULTY OF TECHNOLOGY

The attainment of the above set of objectives would require a certain minimum level in both staffing and physical facilities. It is obvious that the objectives elaborated above will call for additional investment in both physical facilities and man-power of various categories. However, this additional investment can be justified only if the rational use of existing staff and facilities can be demonstrated and found to be inadequate for the task at hand. It is therefore essential to review the present conditions of the Faculty in the areas of space, staffing, student population, and equipment and materials. In this section it intended to present the current capacities and activities of the Faculty and the prevailing constraints in the attainments of its stated goals.

3.3.1 Students

Admission of students to the degree programmes of the Faculty of Technology is the successful completion of the first semester in the Freshman Programme of the Faculty of Science. Students admitted to the Diploma Programme in Building Technology are directly assigned by the Commission for Higher Education. The number of students at the beginning of the second semester of the 1988/89 academic year in the different departments of the Faculty is shown in Table 3.1.

The student population in the Faculty is maximum during the second semester of the academic year when the first year Pre-Engineering and Architecture

and Town Planning graduates are admitted into the Faculty from the Freshman Programme of the Faculty of Science. The Faculty expects to admit approximately 260 students at the beginning of the second semester of the 1989/90 academic year. The maximum student population (headcount) will be 1570 students of whom 970 will be in the departments located at the Northern Campus.

Table 3.1. Regular Student Enrollment by Department and Year: April 1989

DEPARTMENT	Y E A R					TOTAL
	I	II	III	IV	V	
A. Degree Programmes						
1. Architecture and Town Planning	26	21	30	24	76	124
2. Civil Engineering	-	56	92	56	68	302
3. Electrical Engineering		32	47	36	35	154
4. Mechanical Engineering		40	53	51	33	169
5. Pre-Engineering	264	-	-	-	-	264
6. Chemical Engineering		10	19	8	11	57
B. Diploma Programmes						
1. Building Technology	83	72	48			203
TOTAL	373	231	425	183	323	1567

3.3.2 Staff Complement

The number of staff in the Faculty, including those on study leave, is shown in Table 3.2 enumerated by department and academic rank.

Table 3.3: Faculty of Technology - A

	Professor	Associate Professor	Assista Profes
1. Architecture and Town Planning			
. Ethiopian	-	-	
. Expatriate	-	-	
2. Building Technology			
. Ethiopian	-	-	
. Expatriate	-	-	
3. Civil Engineering			
. Ethiopian	-		
. Expatriate	-		
4. Electrical Engineering			
. Ethiopian	-		
Expatriate	-	-	
5. Mechanical Engineering			
. Ethiopian	-	-	
. Expatriate			
6. Chemical Engineering			
. Ethiopian	-	-	
. Expatriate	-		
7. Materials Testing And Research			
. Ethiopian	-	-	
Total			
Percent of total (%)	1.2	14.3	22.

sdemic Staff, April 1986

r	Lecturer	Assistant Lecturer	Graduate Assistant	Total	On Study Leave
	3	2	2	9	5
	1	-	-	5	-
	5	1	3	10	-
	-	-	-	-	-
	-	2	2	22	2
	-	-	-	2	-
	4	-	2	12	1
	-	-	-	1	-
	11	1	1	13	1
	1	-	-	1	-
	2	1	-	3	
	-	-	-	3	
	33	9	14	90	21
	36.5	10.7	14.7	130	

As can be seen from Table 3.2, the percentage of the senior staff members with rank of Associate Professor and above is only 15.5% of which a substantial part are Ethiopians. This indicates that the process of staff development has been slow over the past years of the Faculty's existence.

Nearly 62% of the staff are in the ranks of Lecturer and below. The Faculty's teaching activities are thus mostly taken up by the junior staff members. For rapid staff development it is important to maintain a stable group and provide the necessary conditions in which research activities can be carried out and thus rapid accumulation of experience and advancement through the ranks can be enhanced.

The percentage of expatriate staff members to-date is approximately 15% (percentage) of expatriate staff members has declined substantially over the last 5 years. The employment of expatriate staff members by itself, cannot be considered as a negative factor, so long as their engagement does not create a structure of dependency in the long term. In fact, engaging a given percent of expatriate staff should be a policy so as to help acquire the experience of other universities from overseas.

3.3.3 Space

The Faculty of Technology is located in two campuses. The buildings of the Northern Campus at Arsiri Mic were completed and occupied in 1969. They consist of six lecture halls with an average seating capacity of 70; 12 classrooms with a capacity ranging from 30 to 50; and 7 drawing and design rooms with seating capacity ranging from 15 to 48. A summary of the teaching and laboratory space and offices is shown in Table 3.3.

The facilities at the Northern Campus currently house the departments of Civil, Electrical, Mechanical and Chemical Engineering, a Library and the main Faculty Administration. When these facilities were built, it was expected that the total number of students in these departments will not exceed 600.

Table 3.3: Faculty of Technology – Classrooms, Lecture Halls, Laboratories and Offices, January 1988

Description	Seating Capacity	Description	Seating Capacity
1. Lecture halls	132	6. Electrical Engineering Laboratories	
	96	Fundamentals Laboratory	24
	70	Electronics and Communications Lab.	24
	70	Microprocessor Laboratory	30
	70	Instrumentations Laboratory	15
2. Class rooms	80	Machines Laboratory	26
	40	High Voltage Laboratory	20
	56	Electrical Workshop	20
	54		
	40	7. Mechanical Engineering Laboratories and Workshops	
	38	Workshop (wood, metal and machine workshop)	40
	56	Metallurgy	15
	30	Metrology	15
	31	Metal Test. Laboratory	15
	40	IC Engines Laboratory	20
3. Drawing rooms	47	Combustion Laboratory	15
	48	Refrigration Laboratory	15
	44	Hydraulics Laboratory	15
	44	Vibration Laboratory	15
	44		
	26	8. Offices (58 rooms)	106
4. Drawing rooms	15		
	41		
5. Civil Engineering Laboratories			
Asphalt Laboratory	15		
Hydraulics Laboratory	20		
Building Materials Laboratory	20		
Soil Laboratory	25		
Sanitary Engineering Laboratory	20		

Table 3.6: Faculty of Technology Classrooms, Lecture Halls, Drawing rooms (Southern Campus)

DESCRIPTION	Seating Capacity	Floor Area m^2
1. Classroom	60	
	60	
	50	
2. Lecture Halls	100	
	100	
3. Drawing Rooms	20	
	20	
	40	
	20	
	20	
	15	
	15	
	15	
	15	
4. Design Studio	35	
5. Three Laboratories for Material Testing		700
6. Two materials Stores		350

3.3.4 Equipment and Other Materials

3.3.4.1 Laboratory Equipment

The Faculty has attempted to build up a stock of laboratory equipment for teaching over the years. While most of the laboratory and workshop facilities have been organized when the Faculty was built in 1969, equipment have also been added continuously through foreign grants and purchase using the annual budget allocations. The Faculty's staff members have also designed and produced some equipment using the workshop facilities.

However, some of the equipment in the Faculty's laboratories, in addition to being old, are fast becoming obsolete due to the fast technological changes that are taking place. There is a felt need to constantly, through judicious selection of the new technologies, renew the stock of laboratory equipment. Side by side with the acquisition of additional new equipment, there is also the need to effect a rational organization of the laboratories so as to obtain an optimal use of the available facilities and resources which has, upto now, been hampered by the existing space constraint.

3.3.4.2 Text Books and Other Teaching Materials

There is an acute shortage of text-books and other teaching materials. The stock of text-book in the Faculty have not changed in any meaningful way since the mid-sixties. Over eighty percent of the courses are currently run without any standard text-books and for the ones with standard texts the number of books available, besides being obsolete and in bad physical conditions, are not in sufficient quantities and students are forced to share them often in the ratio of one to five.

The shortage of text-books seriously affects the instruction process. In the absence of a standard text for a given course teachers have to provide notes to students, lectures are time consuming and students do not have the opportunity to work independently.

The staff of the Faculty have, especially over the past five-years, attempted to prepare teaching materials that can be printed in sufficient quantities for the students. In view of the ever increasing cost of technical books of

good quality, the problem of the shortage of texts does not seem to have any solution, in the long run, except the preparation of teaching materials by the staff members. Staff members of the Faculty have to-date produced 15 teaching materials and two textbooks.

3.4 DEVELOPMENT PLAN AND GROWTH PROSPECTS

In the forgoing an attempt was made to show the capacity and capabilities of the Faculty in terms of student population, physical facilities and staff conditions. It was also shown that the Faculty is currently operating well over capacity and that, this is adversely affecting the quality of instruction and research activities. In spite of the constraints and difficulties the Faculty has endeavoured to adequately shoulder its responsibilities in the training of qualified engineers and architects that the country urgently requires. In addition, it has already launched graduate programmes in Civil and Electrical Engineering besides opening a new full-fledged department in Chemical Engineering. It is further working towards introducing a minor programmes of study in Mining Engineering, Metallergy Engineering and Computer Engineering.

In order that the Faculty carry out the objectives stated in Section 3.2, the necessary policy decisions as to the redefinition of the Faculty's role in the overall scheme of the country's development have to be made now. Furthermore, the planning of the required inputs that would enable the Faculty to meet its responsibilities and the execution of the planned activities have to be fixed in time. In view of the growing technical manpower requirements of the country in several fields of specialization at different levels of qualification, proposals are being made, in this Section, to strengthen and expand the Faculty of Technology. The main thrust of these proposals lies in the effective utilization of existing infrastructure and experience to expand into training in new areas of specialization and the strengthening and expansion of existing programmes of study. It further aims at laying the foundation on which other forms of technical training could be built thus affording the country the most rapid development of its technical cadres.

The strengthening and expansion of the Faculty may be accomplished in two phases, namely the short-term of current programmes of study, equipment and staff and the long-term expansion and reorganization of the Faculty in view of the objectives stated at the beginning. The two phases of this plan, need not necessarily be accomplished sequentially in time since one is not a prerequisite of the other. However, for ease of presentation and discussion, the two aspect of the expansion will be discussed separately.

3.6.1 Long-Term Expansion and Growth

The long-term development of the Faculty will be to expand and strengthen existing programmes of study, to expand research and graduate instructions and to launch new programmes of study in other branches of engineering and technology. For the purposes of this proposal, what is meant by long-term will have to remain undefined since this would involve policy matters that will have to take into consideration the over all requirements of the national economy and other investment criteria. However, the following proposals are in general agreement with the goals set by the four-year perspective plan in the main power sector.

The development plan envisages the reorganization of the Faculty, an increase of the student intake, the expansion and strengthening of the programmes of study both at the undergraduate and graduate levels and the expansion of research activities. The additional investments that will be necessary to accomplish the planned activities will also be presented. At this stage of the proposal some of the investment costs presented will of necessity be rough estimates and exact cost will have to be worked out at a later stage.

3.6.1.1 Reorganization of the Faculty

As was mentioned earlier, the facilities of the Faculty are at present located in two Campuses. The main reorganization desired will involve the physical locations of the various functional units of the Faculty so as to help in the rational and effective use of facilities and capabilities. It is therefore, proposed to reorganize the Faculty as follows:

a) Relocate the Department of Architecture and Town Planning at its Northern Campus (Ahmadu Bello Campus). This will have several advantages among which two can be cited as important. Firstly, there are many courses and facilities that are common or related in the programmes of the Civil Engineering Department and Architecture Department and both location in the same campus will facilitate the use of common staff and facilities. Secondly, civil engineers and architects more often work together as a team in their places of employment and the interaction and sharing of common experiences by the students in the two Departments will significantly contribute to their effectiveness after graduation.

b) Use the facilities of the Northern campus for an expanded and strengthened Department of Building Technology and the Material Research and Testing Department. The space that would be available upon the relocation of the Department of Architecture and Town Planning will provide the opportunity to expand the programmes of instruction of Building Technology Department in terms of student intake and type of programmes. It is envisaged that the instructions in this Department will be organised in such a way that middle level technical personnel in the fields of Construction Techniques and Technology will be trained in a strengthened manner. The process of strengthening the instruction in this Department, especially in the practical areas, will be assisted by the Department of Materials Research and Testing.

The Department of Material Research and Testing will have to be strengthened in terms of man-power and equipment so that it would become a centre in which research into new and relevant construction materials and appropriate construction techniques and technologies will be undertaken in addition to its consultancy work.

3.4.1.2 Expansion in Student Intake

The increase in the student intake is governed by the current capacities and the realistic possibilities for the physical expansion that can be undertaken at the two existing campuses of the Faculty. It is therefore, proposed to

increase the student intake of the Faculty from the current 340 student per year in the undergraduate programmes. The requirements for this expansion of student intake and the graduate programmes are presented in Secion 3.4.2. The breakdown of student intakes into the various existing department is presented in Table 3.5.

Table 3.5: Proposed Annual Student Intakes

	Current Student Intake		Proposed Student Intake	
	Undergraduate	Graduate	Undergraduate	Graduate
Architecture and Town Planning	30	-	30	10
Civil Engineering	80	9	100	20
Electrical Engineering	40	5	50	10
Mechanical Engineering	60	-	90	20
Chemical Engineering	30	-	40	-
Sub Total	240	14	310	60
Building Technology	100	14	150	-
Total	340	-	460	60

With an annual intake of 310 students into the various departments offering undergraduate programmes of study and assuming an overall annual rate of attrition* of 20%, the Northern Campus of the Faculty will have a student population of slightly over 1200. This number represents a 30% increase in the undergraduate student population.

The diploma level programme of study in the Building Technology Department will have a student body of about 380 students assuming an overall attrition of 15%.

*Over the past years the attrition rate in the Faculty ranged from 15% to 30%. With improved conditions of study in terms of facilities the assumed attrition rate of 20% seems to be reasonable.

The graduate students will be following programmes of study in different specialized areas within a given engineering discipline. The attrition rate in the graduate programmes is expected to be minimal.

3.4.2 Additional Requirements to Meet the Projected Growth

The projected expansion in the student intake in the undergraduate programmes, the launching of the graduate programmes and the expected growth of the research activities of the Faculty, would require additional investments for additional space, laboratories facilities and academic and technical staff. The additional investment should also aim at alleviating current problems. These requirements are based on the assessments of the Departments of the Faculty, taking into consideration existing conditions, the proposed expansions and current constraints.

3.4.1.2 Space Requirements

Additional space requirements of the Faculty for lecture halls, classrooms and laboratories are presented in Table 3.6. All the indicated additional space will be at the Northern Campus of the Faculty.

The additional classrooms will be required for the added number of students that the Faculty will admit and the proposed relocation of the Department of Architecture and Town Planning. In addition it is proposed to conduct undergraduate classes with only 50 students which necessitate the divisions of certain class into sections.

As can be noted from the Table the largest space requirement is to be for laboratories. This is expected to relieve the currently overcrowded laboratories and also provide the necessary space for organizing research laboratories as separate units from the teaching laboratories which are currently lacking in the Faculty.

The urgent necessity of an expanded space was discussed above. In addition the Faculty would require a multi-purpose auditorium that can be used, among other things, for conducting lectures in courses that are taken by large classes, for conducting examinations and organizing professional lectures and soical and cultural events for the students of the Faculty.

Table 3.6: Additional Space Requirements

	Lecture Hall or Classrooms		Design Rooms		Laboratories		
	Number	Capacity	Number	Capacity	Instructions (m^2)	Research (m^2)	Office (m^2)
1. Architecture and Planning	5	60	5 2	40 20	- -	200 -	150
2. Civil Engineering	4 2	60 30	-	-	-	-	100
. Soil Mechanics Lab	-	-	-	-	-	100	
. Hydraulics Lab.	-	-	-	-	-	100	
. Material and Structures Lab.	-	-	-	-	-	100	
3. Electrical Engineering	2	50	-	-	-	-	100
. Research Labs.	1	30	-	-	-	240	
. Semiconductor and Electronics Techn. Lab.	-	-	-	-	120		
. Control Lab.	-	-	-	-	60		
. Power system Lab.	-	-	-	-	70		
. Electomagnetic Waves Lab.	-	-	-	-	70		
4. Mechanical Engineering	2	90	3	45	-	-	100
. Workshops	-	-	-	-	275	-	
. Laboratories	-	-	-	-	500	-	
. Other Laboratories	-	-	-	-	-	70	
5. Chemical Engineering	3	60	-	-	200	150	100
Sub Total	19	360	8	105	1295	960	550
6. Space for Common Services							
. Library	1	600	-	-	-	-	
. Other Services	-	-	-	-	-	-	200
. Multipurposes Auditorium	1	600	-	-	-	-	
Sub-Total	2	1200	-	-	-	-	200

With the exception of the Library, the proposed additional space requirements can be satisfied by building a third bolck with the associated laboratories and With the exception of the Library, the proposed additional space requirements can be satisfied by building a third bolck with the associated laboratories and workshops.

In the original scheme third bolck and laboratories (shown shaded) was planned to be added when the student intake reaches 1000. Since the Faculty is now proposing to admit more than 1000 students, the addition of the third bolck according to the original plan is justified. It is expected that the cost of building the third block when compared to the investament required to achieve a comparable result by erecting a separate institution will be considerably smaller.

3.4.2.2 Staff Requirements

To carry out the proposed programmes the following will be the minimum requirements in academic and other technical personnel (Table 3.7).

Table 3.7 Staff Requirements

DEPARTMENT	Associate Prof. or above	Lecturer or above	Graduate Assistant	Technicians
1. Architecture and Town Planning	2	3	2	2
2. Civil Engineering	3	4	6	5
3. Electrical Engineering	2	3	4	10
4. Mechanical Engineering	2	3	5	9
5. Chemical Engineering	3	6	5	4
6. Building Technology	3	5	4	8
Total	15	24	26	38

The staff requirements in the senior academic ranks will initially be, at least in part, met by the employment of expatriate staff. It is, however, expected that these positions will eventually be filled by Ethiopian staff, as the junior

members advance into the senior ranks. The enlarged student intake in the undergraduate programmes will of course require the engagement of junior staff members who will often teach independently of even the senior staff members.

The recruitment of qualified technicians to man the expanded laboratories and workshops would be an important component of the overall staff development plan. The effective utilization and maintenance of the laboratory and workshop facilities, in both teaching and research, will require the services of the laboratories and workshops technicians. It will also be necessary to device new organizational structures and staffing to utilize that without the appropriate staffing, the substantial investment in laboratory and workshop facilities cannot be justified.

The development of qualified technical staff will also require the maintenance of a stable group of technical personnel. The Faculty will have to, thus, provide a scheme of training to upgrade the quality of its technicians and also provide an organizational structure through which qualified and deserving personnel can be promoted.

3.8.4 Investment Required for the Expansion of the Faculty

In this Section the estimated costs for the additional constructions proposed in the foregoing sections are presented in tabular form. (Table 3.8). In the Table only the cost estimates for the expansion of the physical facilities as envisaged in the original plan of the Faculty are shown. For estimating of the cost of buildings an average rate of US $ 700 per square meter.

Table 3.8 Estimated cost of additional requirements

	Item	Area in m^2	Cost US$
1.	Lecture Halls & Classrooms	3600	2,520,000
2.	Laboratories	1200	840,000
3.	Workshops	1400	980,000
4.	Multi-Purpose Hall	500	420,000
5.	Library	1000	700,000
6.	Equipment*		1,800,000
7.	Textbooks		200,000
8.	Computers		100,000
9.	Vehicles		100,000
10.	Contigency Cost(5%)		386,000
	Total US$		8,148,000

*Major items in the equipment lists are shown in Table 3.9

Table 3.0 Major items in the Equipment List

	Department	Equipment
1.	Chemical Engineering (₦ 500,000)	Fluid Mechanics Demonstration Rig, Evaporator Demonstration Rig, Distillation Plant, Homogenizer, Stream Generator
2.	Civil Engineering (₦ 500,000)	Field soil Testing Equipment, Surveying Instruments, Concrete Testing Equipment, Water Analysis Test Equipment
3.	Electrical Engineering (₦ 500,000)	Microwave Devices and Measuring Setups, Digital and IC Devices, Antenna Measuring Devices, Digital and Analog Control Devices, Photovoltaic Modules and Energy Conversion Devices
4.	Mechanical Engineering (₦ 500,000)	Universal Governer Apparatus, CAD/CAM System, Numerically Controlled Lathe Machines, Diesel Engines, Petrol Engines, Gear Hobbing Machines.

4. APPENDICES

4.1 APPENDIX A - BIBLIOGRAPHY

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4.2 APPENDIX B - TERMS OF REFERENCE FOR THE CONSULTANT

Aims and Objectives

The Work Assignment given to the Consultant were:

1. Study of existing facilities in selected African Countries (Ghana, Tanzania and Ethiopia) for training of engineers in the Chemical, Civil, Electrical and Mechanical Engineering disciplines.

2. Evaluate the requirements for upgrading such facilities to provide engineering training with a more practical bias on a sub-regional basis.

3. Prepare a detailed techno-economic feasibility study for such upgrading, and make proposals for short and long-term funding for such upgraded institutions.

4.3 APPENDIX C - PERSONS MET DURING THE CONSULTANCY PERIOD

Persons met in University of Science and Technology, Kumasi, Ghana

1.	Prof. F.O. Kwami	- Vice Chancellor, University of Science and Technology
2.	Prof. N.K. Kumapley	- Dean, School of Engineering, Head, Civil Engineering Department
3.	Mr. G.O. Antwi	- Chief Administrative Assistant, School of Engineering
4.	Mr. Y.N. Acheampog	- Head, Chemical Engineering Department
5.	Mr. V.O. Ceasar	- Head, Electrical Engineering Department
6.	Mr. A.A. Duker	- A/Head, Geodetic Engineering Department
7.	Prof. K.O. Kessey	- Head, Mechanical Engineering Department

Persons met in University of Dar-es-Salaam, Dar-es-Salaam, Tanzania

1.	Dr. A.L. Kyulule	- Acting Dean, Faculty of Engineering
2.	Mr. J.B. Mndolwa	- Administrative Officer, Faculty of Engineering
3.	Prof. B.R. Mgombelo	- Head, Electrical Engineering Department
4.	Dr. B.L.M. Mwamila	- Head, Civil Engineering Department
5.	Dr. C.L.C. Migiro	- Head, Chemical & Process Engineering